

Richard J. Roy

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Education

University of Washington (UW)

PhD, Physics

Seattle, WA

2011-2017

University of Puget Sound (UPS)

B.S., Physics with honors

B.S., Mathematics with honors

Summa cum laude

Tacoma, WA

2007-2011

Research and Professional Experience

Jet Propulsion Laboratory, California Institute of Technology

Pasadena, CA

Research Technologist (Aerosols and Clouds group)

2019-Present

NASA Postdoctoral Program Fellow

2017-2019

- Development of an airborne 170 GHz differential absorption radar (DAR) for future applications in satellite remote sensing of atmospheric water vapor.
- Demonstration of first ever all-solid-state cloud radar above 100 GHz.
- RF and microwave engineering and assembly of a frequency-modulated, continuous-wave (FMCW) radar system, including development of radar signal processing architecture and instrument control software.
- Radar retrieval algorithm development for atmospheric state estimation using regularized least-squares and Bayesian optimal estimation approaches.
- Radar instrument calibration and validation of retrieval products from ground-based and airborne measurement campaigns.
- Digital signal processing algorithm development and pulsed, FM waveform optimization for mm-wave radar systems.
- Multi-frequency radar system development and data analysis for cloud microphysics studies.
- Microwave/millimeter-wave scattering calculations for ice cloud particles using T-matrix and discrete dipole approximation (DDA) approaches.
- Radiative transfer modeling for passive and active microwave/millimeter-wave sensors
- Development of spaceborne radar instrument simulators coupled with large-eddy simulation model output.
- Using spaceborne measurement records from active/passive sensors for assessing climate models.

Department of Physics, UW

Seattle, WA

Graduate Researcher

2011-2017

Thesis title: *Ytterbium and Lithium Quantum Gases: Heteronuclear Molecules and Bose-Fermi Superfluid Mixtures*

- Laser cooling and trapping of a mixture of lithium (Li) and ytterbium (Yb) atomic gases to ultracold temperatures ($\approx 10^{-7}$ Kelvin) for studies of strongly-interacting quantum systems, superfluidity, and quantum chemistry.
- Realized the first ever two-element mixture of Bose and Fermi superfluids.
- Numerical and analytical modeling of classical and quantum fluid dynamics for comparison with experiment.
- Developed novel technique based on dynamical shaping of atom traps to achieve fastest cycle time to date for Bose-Einstein condensate (BEC) production.

Department of Physics, UPS

Tacoma, WA

Undergraduate Researcher

2010-2011

- Produced and characterized a supersonic source of metastable helium atoms ($1s2s^3S_1$) prepared by electron impact for applications in mesoscopic imaging and fundamental physics (e.g. tests of QED and matter wave interferometry).

Department of Physics, UW

Seattle, WA

NSF Summer REU Researcher

2010

- Used a single suspended carbon nanotube as a tuned resonator for ambient fluid sensing with single atom sensitivity.

Selected Honors and Awards

- **Voyager Award, JPL**, 2019
Awarded for excellent management of the Vapor In-cloud Profiling Radar (VIPR) project.
- **Henderson Thesis Prize, UW**, 2018
Awarded to one or two graduate students each year for an outstanding PhD thesis.
- **NASA Postdoctoral Program Fellowship, JPL**, 2017
Awarded based on review of research proposal, references, and academic achievements.
- **Hans G. Dehmelt Prize, UW**, 2015
Awarded to one graduate student per year for outstanding achievements in experimental physics.
- **Kenneth Young Memorial Fellowship, UW**, 2011
Awarded to a small number of incoming graduate students based on application strength.
- **Phi Beta Kappa, UPS**, 2011
- **Raymond and Olive Seward Award, UPS**, 2011
Awarded to two students per graduating class in the Department of Physics for outstanding academic achievement.
- **Edward Goman Outstanding Senior Award, UPS**, 2011
Awarded to two students per graduating class in the Department of Mathematics and Computer Science in recognition of superior academic performance.
- **Phi Kappa Phi, UPS**, 2010

Publications

h-index = 10

1. **R. Roy**, K. Cooper, M. Lebsock, J. Siles, L. Millán, R. Dengler, R. Monje, S. Durden, F. Cannon, and A. Wilson, 2021: First Airborne Measurements with a G-band Differential Absorption Radar, *IEEE Transactions on Geoscience and Remote Sensing*, in review.
2. K. Cooper, S. Durden, **R. Roy**, J. Siles, R. Monje, R. Dengler, L. Millán, and R. Beauchamp, 2021: Improving FM Radar Dynamic Range using Target Phase Noise Cancellation, *IEEE Journal of Microwaves*, accepted for publication.
3. K. Lamer, M. Oue, A. Battaglia, **R. Roy**, K. Cooper, R. Dhillon, and P. Kollias, 2020: First Light Multi-Frequency Observations with a G-band radar, *Atmos. Meas. Tech. Discuss.*, <https://doi.org/10.5194/amt-2020-493>, in review.
4. L. Millán, **R. Roy**, and M. Lebsock, 2020: Assessment of global total column water vapor sounding using a spaceborne differential absorption radar. *Atmos. Meas. Tech.*, **13**, 5193–5205, <https://doi.org/10.5194/amt-13-5193-2020>
5. **R. Roy**, M. Lebsock, L. Millán, and K. Cooper, 2020: Validation of a G-band differential absorption cloud radar for humidity remote sensing, *J. Atmos. Oceanic Tech.*, **37**, 1085–1102. <https://doi.org/10.1175/JTECH-D-19-0122.1>
6. K. Cooper, **R. Roy**, R. Dengler, R. Monje, M. Alonso-delPino, J. Siles, O. Yurduseven, C. Parashare, L. Millán, and M. Lebsock, 2020: G-band radar for humidity and cloud remote sensing, *IEEE Transactions on Geoscience and Remote Sensing*. <https://doi.org/10.1109/TGRS.2020.2995325>
7. A. Battaglia, P. Kollias, R. Dhillon, **R. Roy**, S. Tanelli, K. Lamer, M. Grecu, M. Lebsock, D. Watters, K. Mroz, G. Heymsfield, L. Li, and K. Furukawa, 2020: Space-borne cloud and precipitation radars: status, challenges and ways forward, *Reviews of Geophysics*, **58**, e2019RG000686. <https://doi.org/10.1029/2019RG000686>
8. A. Green, J. Toh, **R. Roy**, M. Li, S. Kotochigova, and S. Gupta, 2019: Two-photon photoassociation spectroscopy of the $^2\Sigma^+$ YbLi molecular ground state, *Phys. Rev. A* **99**, 063416. <https://doi.org/10.1103/PhysRevA.99.063416>
9. **R. Roy**, M. Lebsock, L. Millán, R. Dengler, R. Rodriguez Monje, J. Siles, and K. Cooper, 2018: Boundary-layer water vapor profiling using differential absorption radar, *Atmos. Meas. Tech.*, **11**, 6511–6523. <https://doi.org/10.5194/amt-11-6511-2018>
10. **R. Roy**, A. Green, R. Bowler, and S. Gupta, 2017: Two-element mixture of Bose and Fermi superfluids, *Phys. Rev. Lett.* **118**, 055301. Highlighted by the editors as an Editors' Suggestion Article. <https://doi.org/10.1103/PhysRevLett.118.055301>
11. **R. Roy**, R. Shrestha, A. Green, S. Gupta, M. Li, S. Kotochigova, A. Petrov, and C. H. Yuen, 2016: Photoassociative production of ultracold heteronuclear YbLi* molecules, *Phys. Rev. A* **94**, 033413. <https://doi.org/10.1103/PhysRevA.94.033413>
12. **R. Roy**, A. Green, R. Bowler, and S. Gupta, 2016: Rapid cooling to quantum degeneracy in dynamically shaped atom traps, *Phys. Rev. A* **93**, 043403. <https://doi.org/10.1103/PhysRevA.93.043403>

13. W. Dowd, **R. Roy**, R. Shrestha, A. Petrov, C. Makrides, S. Kotochigova, and S. Gupta, 2015: Magnetic field dependent interactions in an ultracold Li-Yb(3P_2) mixture, *New J. Phys.* **17**, 055007. <https://doi.org/10.1088/1367-2630/17/5/055007>
14. A. Khramov, A. Hansen, W. Dowd, **R. Roy**, C. Makrides, A. Petrov, S. Kotochigova, and S. Gupta, 2014: Ultracold heteronuclear mixture of ground and excited state atoms, *Phys. Rev. Lett.* **112**, 033201. <https://doi.org/10.1103/PhysRevLett.112.033201>
15. A. Hansen, A. Khramov, W. Dowd, A. Jamison, B. Plotkin-Swing, **R. Roy**, and S. Gupta, 2013: Production of quantum degenerate mixtures of ytterbium and lithium with controllable inter-species overlap, *Phys. Rev. A.* **87**, 013615. <https://doi.org/10.1103/PhysRevA.87.013615>
16. H.-C. Lee, O. Vilches, Z. Wang, E. Fredrickson, P. Morse, **R. Roy**, B. Dzyubenko, and D. Cobden, 2012: Kr and ^4He adsorption on individual suspended single-walled carbon nanotubes, *J. Low Temp. Phys.* **169**:338-349. <https://doi.org/10.1007/s10909-012-0642-3>

Teaching Experience

Seattle University, Adjunct physics professor

UCOR 1810: The World of Light

Winter 2017

Designed curriculum and taught course on waves, optics, and light phenomena (lecture and lab) for non-physics majors.

University of Washington, Graduate student

Teaching Assistant, Physics 121: Mechanics

Fall 2011

Led weekly tutorial sections in which students worked through mechanics problems in small groups.

University of Puget Sound, Undergraduate student

Physics Tutor, Center for Writing, Learning and Teaching

2010-2011

Tutored undergraduate physics and mathematics students of all levels as the university's head physics tutor.

Teaching Assistant, Math 301: Differential Equations

Spring 2010

Teaching Assistant, Physics 221: Modern Physics

Fall 2009

Teaching Assistant, Physics 121/122: Gen. Univ. Physics I & II

2008-2009

Funded Proposals

JPL Principal Investigator, NASA ACT (ROSES 2020): *A compact, high-Power 167-174.8 GHz traveling-wave tube amplifier for planetary boundary layer differential absorption radar* (\$240k over 2.5 years)

Co-Investigator, NASA AITT (ROSES 2019): *Upgrading VIPR for routine pressurized aircraft deployment in science field campaigns* (\$1100k over 3 years)

Co-Investigator, NASA IIP (ROSES 2019): *CloudCube: Development of a low-cost, low-volume Ka/W/G triple-frequency cloud and precipitation radar system* (\$4500k over 3 years)

Co-Investigator, NASA MatISSE (ROSES 2018): *WASSR: WATER-vapor Sounding Short-range Radar for mapping local atmospheric humidity over the Martian surface from an in situ platform* (\$3000k over 3 years)

Fellow, NASA Postdoctoral Program (USRA/NASA 2017): *An integrated radar and radiometer at 183 GHz for optimized humidity profiling* (fellowship stipend and travel funds)

Research Talks

JPL Center for Climate Sciences Seminar (Invited Talk); June 12, 2020; Pasadena, CA. "G-band cloud radar developments at JPL"

AGU Fall Meeting; December 9, 2019; San Francisco, CA. "Validation of the Vapor In-cloud Profiling Radar (VIPR): A G-band differential absorption cloud radar for boundary-layer humidity remote sensing "

39th International Conference on Radar Meteorology; September 17, 2019; Nara, Japan. "The Vapor In-cloud Profiling Radar (VIPR): Field deployment and validation of in-cloud humidity profiles"

JPL Section 334 Radar Forum (Invited Talk); January 11, 2019; Pasadena, CA. "The Vapor In-cloud Profiling Radar (VIPR): A G-band cloud radar for boundary-layer water vapor profiling"

AMS Annual Meeting; January 10, 2019; Phoenix, AZ. "Boundary-layer humidity sounding in cloudy and clear skies using differential absorption radar"

AGU Fall Meeting; December 10, 2018; Washington, DC. "Boundary-layer water vapor profiling inside of clouds"

using differential absorption radar”

16th European Radar Conference; September 26, 2018; Madrid, Spain. “Differential absorption radar at 170 GHz for atmospheric boundary layer water vapor profiling”

NASA 2018 Earth Science Technology Forum; June 12, 2018; Silver Spring, MD. “Boundary-layer humidity sounding using a G-band differential absorption radar”

29th IEEE International Symposium on Space Terahertz Technology; March 27, 2018; Pasadena, CA. “Differential absorption radar near the 183 GHz water absorption line for inside-cloud humidity profiling”

APS Division of Atomic, Molecular, and Optical Physics Meeting; June 2017; Sacramento, CA. “Two-Element Mixture of Bose and Fermi Superfluids”

Invited talk at Seattle University, Physics and Astronomy Seminar (Hosted by David Boness); November 2, 2016; Seattle, WA. “Experiments with a quantum gas mixture of lithium and ytterbium”

APS Division of Atomic, Molecular, and Optical Physics Meeting; May 2016; Providence, RI. “Rapid cooling to quantum degeneracy in dynamically shaped atom traps”

Invited Talk at the University of Puget Sound, Physics Colloquium (Hosted by Amy Spivey); April 8, 2016; Tacoma, WA. “Exploring quantum phenomena with an ultracold mixture of lithium and ytterbium”

APS Division of Atomic, Molecular, and Optical Physics Meeting; June 2015; Columbus, OH. “Formation of LiYb molecules by photoassociation”

APS Northwest Section Meeting; May 2014; Seattle, WA. “Combining ultracold quantum gases of Yb and Li atoms”

APS March Meeting; March 2012; Boston, MA. “Photo-induced chiral edge current in Bi₂Se₃ nanoribbons”

Poster Presentations

JPL Postdoc Research Day; June 2018; Pasadena, CA. “Differential absorption radar near 170 GHz for remote sensing of boundary layer water vapor”

International Conference on Atomic Physics; July 2016; Seoul, Korea. “¹⁷⁴Yb and ⁶Li mixtures: rapid quantum degenerate gas production and large mass-mismatched Bose-Fermi dual superfluid studies”

Joint MURI Workshop on Ultracold Chemical Reactions; November 2015; Harvard University, MA. “Combining ytterbium and lithium: Routes to ²Σ molecules”

Joint MURI Workshop on Ultracold Chemical Reactions; November 2014; University of California, Los Angeles, CA. “Combining lithium and ytterbium: Strongly-interacting mixtures and photoassociative production of YbLi*”

International Conference on Atomic Physics; August 2014; Washington, D.C. “Magnetic field dependent inelastic scattering in an ultracold mixture of lithium and metastable ytterbium”

APS Division of Atomic, Molecular, and Optical Physics Meeting; June 2014; University of Wisconsin, Madison, WI. “Magnetic field dependent inelastic scattering in an ultracold mixture of lithium and metastable ytterbium”

Professional Activities

- **Memberships:** American Geophysical Union, American Physical Society
- **Peer Review:** Atmospheric Measurement Techniques, Optics Express, IEEE, Journal of Atmospheric and Oceanic Technology